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The University of Iowa Biomass Energy Sustainability Index: A decision-making tool for the University of Iowa Biomass Partnership Project

Abstract

Work continued on a plan to increase the renewable, sustainable fuel sources available to power operations at the University of Iowa in Iowa City. A team of researchers from multiple institutions collaborated to create a tool that would allow the UI to evaluate its alternative energy options more effectively.

Keywords

Bioeconomy and energy, Climate change greenhouse gas emissions, Life Cycle Assessment, Economic and environmental impacts, Models and assessment tools, Policy, Supply networks

Disciplines

Natural Resources Management and Policy | Operations and Supply Chain Management | Statistical Models | Sustainability

Lead Investigators

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A decision-making tool for the University of Iowa Biomass Partnership Project

Abstract: Work continued on a plan to increase the renewable, sustainable fuel sources available to power operations at the University of Iowa in Iowa City. A team of researchers from multiple institutions collaborated to create a tool that would allow the UI to evaluate its alternative energy options more effectively.

Principal Investigator:

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Co-investigators:
13 faculty members from University of Iowa, Iowa State University and University of Northern Iowa

Budget:
\$30,000 for year one

Q When a variety of biomass-based solid fuels are available to be co-fired to generate steam and/or electricity (in this case, specifically at the University of Iowa), which are the more sustainable choices and why?

A The University of Iowa has identified more than 20 potential biomass fuel sources. The UI is employing the triple bottom line of sustainability – environment, equity, economy – as a framework for decision-making, and applying this framework to fuel selection is an extension of that commitment. An energy sustainability fuel index that could be used by easily and effectively by power plant managers as a decision-making tool appeared to be an achievable task.

Background

The Energy Sustainability Index (ESI) project is a continuation of the Biomass Partnership Project. BPP was formed to identify and develop a bio-renewable fuel supply for the University of Iowa (UI) Main Power Plant to help reach the UI goal of 40 percent renewable energy use by 2020. The BPP has identified more than 20 potential biomass fuel sources.

The Energy Sustainability Index project was intended to develop a decision making tool for the UI to evaluate locally available renewable energy sources using the sustainability triple bottom line (TBL) accounting framework. The framework of categories and indicators in the ESI may be revised or expanded in the future to evaluate other fuel sources such as solar, wind or fossil fuels and can be made available for use by other institutions.

Overarching principles that guide ESI development include:

- Maximize financial resources while protecting natural and social capital;
- Consider the complex ecological, financial, and social systems and their interrelatedness;
- Protect land, water, and atmospheric systems on which humans and other living species depend;
- Cultivate biomass with a precautionary and adaptive approach; and
- Identify short- and long-term needs that support prosperity for Iowans.

Approach and methods

The project team included faculty and staff from the University of Iowa (UI), Iowa State University (ISU) and the University of Northern Iowa (UNI). Co-investigators had expertise in agronomy, ecology, plant breeding and genetics, economics, engineering, geography, and energy history. Utility managers employed through the UI Facilities Management and stakeholder consultation (i.e., peer reviewers) also informed the development of the ESI.



A view into the stoker boiler, UI main Power Plant

A review of current literature was categorized into six main themes: sustainability indices/indicators; process; managing uncertainty and risk; bioenergy; co-firing; and renewable energy policy. An executive summary provides a summary of the main findings from the review and an annotated bibliography is provided of the reviewed literature.

The project team developed an evaluation framework that is scientifically grounded in peer-reviewed literature and incorporates values and opinions of UI stakeholders. The indicators selected for inclusion in the ESI are not meant to be static. The project team based the current set of indicators on peer-reviewed literature, regulatory guidelines, management documents, white papers, and UI stakeholders. The list of indicators is meant to change over time as new energy-related concerns emerge and others are improved or solved.

Results and discussion

The ESI used a locally driven decision making process while simultaneously drawing clear connections to regional, national and international energy challenges and implications. Due to the complexity and data requirements of the ESI, approximations and best management practices were used as benchmark data. The project team conducted a literature review to gain insights into the current research on fossil fuel and renewable energy indices. Researchers have used many different indicators and indices to assess sustainability, but the project team was unable to find research validating indicators on a local scale relative to this project. During ESI development, input from co-investigators and project reviewers helped validate findings from the literature. An explanation for indicator selection and data is provided in the ESI justification document.

The project team gained insights into stakeholder attitudes concerns and perceptions through four focus groups.

- The project team held focus groups on November 19 and 21, 2014 and to gather information about stakeholder experiences, concerns, and attitudes toward the sustainability of biomass-derived renewable energy sources. Participants were recruited through email for their experience in energy or sustainability in the local area.

Focus groups were held at the University Capitol Center on the UI campus (Iowa City, IA). Participants included members of the UI community, industry, and professionals in energy or sustainability related positions in the community. Results are available in the report titled, “Investigating stakeholder values, perceptions, and concerns about biomass-derived energy in the State of Iowa.” (This report is available on request from the principal investigator.) Focus group data were used to inform category and indicator identification as well as the overall communications strategy. The report includes a framework for future stakeholder engagement and data collection opportunities.



Wood chips mixed with coal at the UI main Power Plant

- On March 5 and 12, 2015, the project team conducted two focus groups with UI students enrolled in Contemporary Environmental Issues and U.S. Energy Policy classes. Students were able to engage in a discussion about the UI pursuing biomass energy. The two student focus groups were analyzed separately as the research methods were different. The results from the student focus groups informed the methodology for future stakeholder engagement and the broader UI energy communications strategy and highlighted the desire for students to have more information on energy.

From the literature search, input from researchers and results from the focus groups, a prototype energy sustainability index was developed to be used at the UI main Power Plant. Indicators were selected for their relevance to the University of Iowa's renewable energy goal and its interest in biomass energy production. The Energy Sustainable Index will be used by UI energy managers and will be made available to other parties on request.

Conclusions

The ESI development process highlighted the need for UI to integrate data collection mechanisms into the entire energy system. Additional data collection mechanisms are needed for more accurate assessments of indicators, especially those with global implications. In the future, a scale system (0-100) could be implemented for each indicator. A refined scale could more accurately reflect the current state of indicators.

To set boundaries for data collection, a one-year time scale was suggested for indicators. This duration has limitations as many indicators may have different results over a multi-year time scale. Also, opportunity fuels such as timber stand improvement have a shorter time scale. Additional work could address concerns with variable time scales so that fuels may be more accurately compared to one another. More engagement with energy stakeholders also is necessary to accurately weigh the ESI using the stakeholder engagement framework.

The project team created a separate list of indicators that are not currently measurable or could not be evaluated at this time with current institutional resources. These indicators show a need for future research and development. Data availability for industrial by-products is particularly challenging. Information may be proprietary, or the complexity of the system may make it burdensome to track. Due to data limitations and inherent complexity in evaluating products developed outside of Iowa, a limited number of indicators may need to be used for industrial by-products.

Impact of results

This tool allows the UI to evaluate the broader impacts of the biomass energy supply chain and empowers decision-makers to take action at the project's beginning to mitigate future ecological and financial burdens. Other institutions, businesses, and parties interested in increasing renewable energy consumption through the use of sustainable fuels could employ the framework as a guide.

The list of indicators is meant to change over time as new energy-related concerns emerge and others are revised or addressed. Indicator measurement will improve as more research and data become available. Development of additional methods is needed to accurately compare environmental and societal impacts of energy choices. The ESI score acts as a baseline sustainability measurement and the user can identify high- and low-performance areas to serve as a basis for future investigation. The ESI also may be helpful for institutions to use when requesting information from energy suppliers.

Education and outreach

- Ingrid Gronstal Anderson and Sara Maples co-presented at the Big 10 and Friends Mechanical and Energy Conference held at the University of Iowa in October 2014.
- Ingrid Gronstal Anderson spoke at the International Biomass Conference and Expo in Minneapolis, Minnesota in April 2015.
- Ingrid Gronstal Anderson and Sara Maples co-presented at Iowa State University as part of the EPSCOR series.
- The project team engaged UI facilities management by participating in monthly biomass meetings at the Main Power Plant. Connecting with power plant operators informed ESI development and provided an opportunity to update the group on the ESI.

A bio-renewables field day was hosted by Iowa Learning Farms at the Iowa City miscanthus plot on September 10, 2014. Over 70 people attended including representatives from the Iowa Department of Natural Resources, Clear Creek Watershed Steering Committee, Kirkwood Community College, the Iowa Initiative for Sustainable Communities, the Johnson County Conservation Board, State Senator Robert Dvorsky, State Representative Sally Stutsman, Johnson County Supervisors Pat Harney and John Etheredge, Iowa Regent Robert Downer, University of Iowa students, as well as UI faculty, and staff, local community members, local agricultural producers, and local media. Co-investigator Emily Heaton from ISU spoke as did Dan Black, owner of the miscanthus field, and Ben Anderson, manager of the University of Iowa Power Plant.

Information on the ESI was added to the University of Iowa's Office of Sustainability website <http://sustainability.uiowa.edu/initiatives/biomass-fuel-project/biomass-sources/biomass-energysustainability-index/>.

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